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Analysis of trade-offs from the use of hydrogen blended with natural gas in the European Union

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Context: Increasing use of hydrogen (H_2) across the economy is currently seen as an important strategy for decarbonization of fossil fuel-dependent sectors. Energy scenarios, especially those aiming at net-zero GHG emission targets, project that surplus electricity produced from renewable sources, such as solar and wind, will be converted and stored as H_2 by electrolysis. The use of pure hydrogen would require the replacement or significant modification of some of the infrastructure (e.g. steel pipelines) and end-use appliances (e.g. combustion engines) by H_2-dedicated equipment (e.g. PE/PVC pipelines, fuel cells); in fact, many sectors are already moving towards these solutions. However, hydrogen can also be blended into natural gas and used in the same applications. The combustion of such blends enables reduction of carbon intensity in several sectors without significant technological retrofits. However, hydrogen combustion under lean air conditions leads to higher thermal formation of nitrogen oxides (NOx), when compared to natural gas. The amount depends on the burner type, load and hydrogen blending ratio. While NOx emissions pose a direct risk to human health and act as a precursor to the O_3 and particulate matter, deployment of H_2 would also result in direct leakages to atmosphere and associated climate impacts.

Objective: This study seeks to quantify and evaluate the potential NOx increases in the European Union (EU27) countries due to the combustion of hydrogen blended with natural gas.

Methodology: We use GAINS model framework to conduct this analysis assuming that hydrogen combustion will mostly take place in the buildings, industry (boilers and furnaces) and power generation sectors. The exclusion of the transport sector is justified by the predominant use of hydrogen in fuel cell vehicles, which do not contribute to NOx formation. Since hydrogen blends will be used in the same devices as currently natural gas, existing abatement technologies as well as their adoption rates are kept across all sectors and regions.

Expected Results: We expect the results of this study will allow us a better understanding of hydrogen impacts in terms of pollutant emissions. While the paper asserts that the findings are unlikely to influence the development or viability of future hydrogen economies in Europe, it acknowledges the importance of the analysis in revealing potential emissions trends and identifying local or country-specific trade-offs. The emphasis on existing regulations and emission control strategies in Europe provides context for the limited air quality impacts expected on the overall trajectory of hydrogen adoption. Moreover, these preliminary results could lead to relevant

insights regarding expected H^2 fugitive emissions which may impact climate mitigation targets and economical viability.